PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 2005 FB 101 E	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/EP2005/001058	International filing date *(day/month/year)* 03.02.2005	Priority date *(day/month/year)* 27.02.2004
International Patent Classification (IPC) or national classification and IPC INV. B29C67/24 B28B11/24 H05B6/64 B29C67/00		
Applicant TONCELLI, Luca		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 8 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand 12.12.2005	Date of completion of this report 18.05.2006
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer Orij, J Telephone No. +31 70 340-4563

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2005/001058

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:

   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages	
1-6	received on 12.12.2005 with letter of 09.12.2005
Claims, Numbers	
1-6	received on 12.12.2005 with letter of 09.12.2005
Drawings, Sheets	
1/1	as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2005/001058

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-6
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-6
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-6
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (SEPARATE SHEET)

International application No.
PCT/EP2005/001058

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:
   D1: EP-A-0 786 325 (TONCELLI, MARCELLO) 30 July 1997 (1997-07-30)
   D2: US-A-3 953 703 (HURWITT ET AL) 27 April 1976 (1976-04-27)
   D3: ETMANSKI B ET AL: "HOCHGEFUELLTE DUROPLASTE (TEIL 1). \HAERTUNG VON EPOXIDHARZBETON MIT MIKROWELLEN" PLASTVERARBEITER, ZECHNER UND HUETHIG VERLAG GMBH. SPEYER/RHEIN, DE, vol. 43, no. 7, 1 July 1992 (1992-07-01), pages 64-66, XP000293307 ISSN: 0032-1338

2.1 The document D1 discloses (the references in parentheses applying to this document) a method for manufacturing sheets of agglomerate material comprising, in succession the following steps:
- preparation of a mix by mixing inert materials of predetermined particle size with an organic binder,
- distribution of said mix inside a tray mould so as to form a layer of mix,
- vacuum vibro-compaction in order to obtain a compacted sheet, and
- catalytic hardening of the organic binder by means of heating ovens in order to obtain the final sheet (claim 1).

The subject-matter of claim **1** therefore differs from D1 in that at the end of said vibro-compaction step, an additional step which consists in subjecting the compacted sheet to a dielectric preheating by means of electromagnetic waves of a frequency less than 300 MHz in order to attain a temperature lower than the temperature at which the catalysis of the binder starts.

The subject-matter of claim **1** is therefore new (Article 33(2) PCT).

The objective problem underlying claim **1** appears to be how to reduce the time required for the hardening step (cf. description page 1, line 24 - page 2, line 33).

Although dielectric preheating of a cast layer of ceramic slip to enhance the evaporation of the solvent from the slip, preferably done at a frequency of 2850 MHz is known from document D2 (column 2, lines 23-52, claims 1-3) and

document D3 generally teaches the replacement of oven heating by microwave heating at 2450 MHZ for a mix of stone materials with a binder consisting of organic resins, the man skilled in the art is neither hinted by D2 nor by D3 to come to the solution as proposed by claim **1**.

The subject-matter of claim **1** is therefore considered as involving an inventive step (Article 33(3) PCT).

2.2 The document D1 discloses also (the references in parentheses applying to this document) a plant for manufacturing sheets of agglomerate material using the method according to any one of the preceding claims and comprising, in succession,

- a first station for preparing a mix by mixing a granulate of predetermined particle size with a binder consisting of organic resins,
- a second station for distributing said mix inside a tray mould so as to form a layer of mix,
- a third vacuum vibro-compaction station for obtaining a compacted sheet,
- and a final hardening station comprising at least one heating oven for catalysis of the organic binder so as to obtain the final sheet (column 1, lines 18-33, figure 1)

The subject-matter of claim **6** therefore differs from D1 in that an intermediate station is arranged between said third vibro-compaction station and said final hardening station and comprises means for generating of electromagnetic waves having a frequency less than 300 MHZ for preheating said compacted sheet up to a temperature lower than the temperature at which the catalysis of the binder starts.

The subject-matter of claim **6** is therefore new (Article 33(2) PCT).

The objective problem underlying claim **6** appears to be how to reduce the time required for the hardening step (cf. description page 1, line 24 - page 2, line 33).

For the same reasons set out in the above paragraph can the subject-matter of claim **6** be considered as involving an inventive step (Article 33(3) PCT).

3. Claims **2-5,7** respectively are dependent on claims **1 and 6** respectively and as such also meet the requirements of the PCT with respect to novelty and inventive step.

4. The subject-matter of claims **1-6** is considered as susceptible of industrial application (Article 33(4) PCT).

Re Item VIII

Certain observations on the international application

1. The feature "granulates" is missing from claim **4**, see description page 4, lines 9,10.

2005 FB 101 E

Method for manufacturing sheets of agglomerate material using dielectric heating and associated plant.

* * * * *

The present invention relates to an improvement in the technology used for manufacturing sheets or tiles of agglomerate material, also known as Bretonstone technology.

This technology envisages a succession of steps, the main ones of which are:

- the preparation of a mix obtained by mixing together granulated stone materials together with a binder, generally consisting of organic resins;
- the distribution of the mix thus obtained inside a tray mould in a uniform manner so as to obtain a layer of mix with a constant thickness;
- compaction of the mix, which is performed under vacuum conditions, by applying a given vibrating movement to the tray containing the layer of mix, thus obtaining a sheet of compacted material;
- a step involving hot-hardening or catalysis of the compacted sheets, performed preferably in ovens with heating surfaces inside which the tray moulds are stacked; these ovens normally operate at a temperature ranging between 85°C and 140°C and preferably between 100°C and 120°C.

This technology, which is now well-established *and is the subject matter of several patents and patent applications, such as EP-A-0 786 325 (corresponding to IT-A-1 288 566)*, allows sheets of agglomerate material with notable mechanical and aesthetic properties to be obtained in an efficient manner.

However, the time required for the hardening step is considerably greater than that of the vacuum vibro-compaction step, causing a number of problems.

In fact, the hardening step envisages a long transitory preheating period (about 8/15 minutes depending on the thickness of the sheet and the temperature of the surfaces) which heats the compacted sheet to the temperature for activation of catalysis (normally about 80°C) and, subsequently, a period (about 6/8 minutes) where the compacted sheet remains at the catalysis temperature (about 100°C). In this connection it must be pointed out that the catalysis reaction is exothermic, so that, after activation thereof, there is a sudden rise in the temperature of the article equivalent to a few tens of degrees.

Owing to the heat conduction coefficient of the mix, which is relatively low, during the abovementioned transitory period, the internal part of the compacted sheet is heated at a later time than the external part.

It is also indispensable that the heating surfaces should have a perfect geometry and that the temperature should be perfectly uniform not only over the whole area of the surfaces but also between one surface and the next: substantial temperature gradients, namely differences in temperature between different zones of the sheet to be hardened, cause unacceptable distortion of the sheet. The catalysis and hardening of the article are in fact accompanied by substantial dimensional shrinkage, so that varying catalysis kinetics in different zones result in non-uniform shrinkage kinetics.

On the other hand, it is of fundamental importance to obtain, as a final result, sheets which are perfectly flat and, therefore, necessarily the increase in temperature during the transitory period must occur in a perfectly uniform manner over the entire surface and possibly throughout the thickness of the sheet.

It should be noted that the overall duration of the hardening step depends to a large extent on the duration of the transitory preheating period which, in turn, is dependant on the thickness of the compacted sheet and its composition. The greater the thickness of the compacted sheet and/or the lower the heat conduction coefficient of the material forming the compacted sheet, the more difficult will be transmission of heat from the outside towards the inside of the sheet, so that heating must be slower and therefore the time required for the transitory period will be greater.

It should be noted now that the duration of the vibro-compaction step is normally about 100 seconds and that the duration of the step involving hardening of the compacted sheet is always greater than 15 minutes and may even be as high as 25 minutes.

Since the catalysis time is therefore about 15 times greater than the time required for vibro-compaction, a hardening station with a capacity - in terms of the number of sheets which it is able to contain - of at least 15 is required. Usually the ovens used have 15-18 compartments, each of which is able to receive a sheet to be hardened.

The ovens used, moreover, are per se fairly complex since, as already commented, during the hardening step, the sheet must be kept at a constant and perfectly uniform temperature. In particular, such ovens have notable dimensions and therefore have negative repercussions on the bulk, the final cost and the running of the plant.

As already mentioned above, when it is required to manufacture sheets of

considerable thickness or sheets containing a granulate with a low heat conduction coefficient, the time required for the hardening step is increased considerably.

For example, if it is required to manufacture sheets of agglomerate with a low weight, such as that described in *WO-A-2005/030474 (claiming the priority* of Italian Patent Application No. TV2003A000134 filed on 29 September 2003 in the name of Dario Toncelli) it was found that, owing to the low heat transmission coefficient of the expanded granulates which form part of the mix, the time required for hardening increases to even as much as 45 minutes. In such conditions the catalysis oven would assume dimensions and a complexity which are practically unacceptable such that a plant of this kind would be uneconomical.

The object of the invention is therefore that of eliminating the drawbacks mentioned above and in any case ensuring that the construction of a plant is economical even in the case where thicknesses of the sheets to be obtained are considerable or in the case where granulates with a low heat conduction coefficient, such as expanded granulates, are used.

It is worth mentioning that, according to US-A-3 953 703, it is known to submit a cast ceramic slip (of a thickness of 0.035-0.038 inches, corresponding to about 1 mm) to the typical microwave heating at 2450 MHz with the purpose of partially evaporating the solvent comprised in the slip before the slip is conveyed through a drying chamber. Microwave heating at 2450 MHz has also been proposed for hardening mixtures of concrete comprising organic (epoxy) resins by B. Etmanski and A. K. Bledzki in "Plastverarbeiter", 1992, No. 7..

The object is achieved with a method for manufacturing sheets of agglomerate material comprising, in succession *the following steps* :

- ~~a first step involving~~ preparation of a mix by mixing inert materials of predetermined particle size with an organic binder,
- ~~a second step involving~~ distribution of said mix inside a tray mould so as to form a layer of mix,
- ~~a third step involving~~ vacuum vibro-compaction in order to obtain a compacted sheet, and
- ~~a fourth step involving~~ *catalytic* hardening of the organic binder by means of heating ovens in order to obtain the final sheet,

characterized ~~*in that*~~ *by an additional step at the end of said vacuum vibro-compaction step* ~~an intermediate step involving~~ *which consists in subjecting* ~~dielectric preheating of~~ the

compacted sheet *to a dielectric preheating step by means of electromagnetic waves of a frequency less than 300 MHz in order to attain a temperature lower than the temperature at which catalysis of the binder starts.* ~~is introduced between said third vacuum vibro-compaction step and said hardening step~~.

In this way the transitory preheating step is performed outside of the catalysis oven, thus reducing substantially the amount of time the sheets to be catalysed spend inside them. There is a reduction in the number of compartments inside the catalysis oven and therefore also in its size and consequently also the complexity of the plant.

These advantages are even more evident in the case of sheets which have a considerable thickness or use granulates of the expanded type.

Advantageously, the intermediate step of preheating the compacted sheet is performed by means of dielectric heating, and in particular using radiofrequency waves, which ensure uniform and rapid heating of the article, the cycle having a duration compatible with that of the vibro-compaction step.

In this way the sheet is preheated no longer by means of conduction, transmitting the heat from the heating surfaces of the oven to the said sheet, but also owing to the fact that the heat is generated directly inside the sheet where the direct conversion of the energy from electromagnetic energy to thermal energy occurs.

The efficiency of this type of heating is such as to reduce significantly the preheating time, making it compatible with the vibro-compaction time and ensuring perfectly uniform heating throughout the thickness and over the whole surface, with enormous advantages.

The invention also relates to the associated plant for implementing the method referred to above.

These advantages, together with others, will emerge more clearly from the following detailed description of a plant according to the invention, provided by way of a non-limiting example, with reference to the accompanying drawing in which Figure 1 is a perspective view of a plant designed in accordance with the present invention.

Figure 1 denotes overall by 10 a plant for manufacturing sheets of agglomerate material of the type described in ~~Italian Patent No. 1,288,566~~ *EP-A-0 786 325*. The plant 10 comprises a first station 20 for preparing a mix formed by mixing granulates of different materials, such as natural and non-natural stone materials, together with an organic binder, such as for example polyester or epoxy or acrylic or epoxy vinyl

resins.

Thereafter the plant envisages a second station 30 for distribution of the mix inside a tray mould 12 in a uniform manner, so as to obtain a soft layer of mix of substantially constant thickness. The tray mould 12 is removed from a store 16 situated at the front of the plant 10. A sheet 14 of material identical to that (not shown) forming the bottom of the tray mould is deposited on top of the mix distributed inside the tray mould.

The mould 12 enclosing the layer of mix is transferred to a third vacuum vibro-compaction station 40 where it undergoes deaeration by means of a very intense vacuum and then vacuum vibro-compaction by means of application of a pressure with a vibratory movement, thus producing a sheet of compacted material.

According to a fundamental characteristic feature of the present invention, the mould 12 containing the compacted sheet is then transferred to an intermediate station 50 for preheating by means of electromagnetic radiofrequency waves where the compacted sheet is heated and brought rapidly to a temperature slightly below that at which catalysis starts (about 78°C).

Finally, the mould is introduced inside a conventional catalysis oven 60 consisting of pairs of heated surfaces (at a temperature of about 100-120°C) onto which the trays with the sheets to be catalysed are inserted, the catalysis reaction taking place there on a support which is perfectly flat.

The intermediate radiofrequency preheating station 50 allows the compacted sheet to be heated in a short time (less than 100 seconds) and in a perfectly uniform manner until the temperature at which catalysis starts is reached. The station 50 may in particular be constructed in the form of a tunnel oven.

In particular the compacted sheet is subjected for a duration of less than 100 seconds to radiofrequency waves having a frequency of less than 300 MHz (maximum limit) and preferably ranging between 25 and 35 MHz. The frequency is chosen so as to ensure an optimum heating efficiency depending on the type of resin and inert material with which the material of the mix is formed.

It should be noted that in this way the generation of the heat is performed directly inside the compacted sheet so that preheating occurs very rapidly and in a uniform manner throughout the thickness of the sheet, without the risk that temperature differences are generated between the outer part and inner part or different zones of the sheet, thus preventing the said sheet from curving or bending.

The preheating time is approximately only 80 seconds and is substantially dependent upon the thickness of the sheet and its composition.

Considering that in conventional plants the overall time required for catalysis varies from a minimum of 15 minutes to a maximum even as high as 45 minutes, as mentioned above, and that most of this time was required in order to heat the sheet slowly and gradually to the catalysis temperature, the enormous advantage achieved is obvious.

In fact the catalysis station according to the present invention is composed of few pairs of heating surfaces and, in the specific case, of only 5 compartments, whereas, in the corresponding conventional plant, the compartments would instead have been 15 in number and even many more in the case where expanded light inert material (granulates) is used.

The plant is this considerably simplified with resultant advantages.

It is obvious that conceptually or functionally equivalent modifications or variants *within the scope of the appended claims* ~~of the present invention~~ are possible and may be envisaged ~~and fall within the scope of the present invention~~.

* * * * *

CLAIMS

1. Method for manufacturing sheets of agglomerate material comprising, in succession *the following steps* :

- ~~a first step involving~~ preparation of a mix by mixing inert materials of predetermined particle size with an organic binder,
- ~~a second step involving~~ distribution of said mix inside a tray mould so as to form a layer of mix,
- ~~a third step involving~~ vacuum vibro-compaction in order to obtain a compacted sheet, and
- ~~a fourth step involving~~ *catalytic* hardening of the organic binder by means of heating ovens in order to obtain the final sheet,

the method being characterized, *at the end of said vacuum vibro-compaction step,* ~~*in that*~~ *by an additional step* ~~an intermediate step involving~~ *which consists in subjecting* ~~dielectric preheating of~~ the compacted sheet *to a dielectric preheating by means of electromagnetic waves of a frequency less than 300 MHz in order to attain a temperature lower than the temperature at which catalysis of the binder starts.* ~~is introduced between said third vacuum vibro-compaction step and said hardening step~~.

~~2. Method according to Claim 1, characterized in that said intermediate step involving dielectric preheating of the compacted sheet is performed by means of heating with electromagnetic radiofrequency waves having a frequency of less than 300 MHz.~~

~~3.~~ 2. Method according to Claim ~~2~~ 1, characterized in that said radiofrequency waves have a frequency ranging between 25 and 35 MHz.

~~4.~~ 3. Method according to any one of the preceding claims, characterized in that, during the said intermediate preheating step, the compacted sheet reaches a temperature ~~lower than the temperature at which catalysis of the binder starts and preferably~~ ranging between 75°C and 78°C.

~~5.~~ 4. Method according to any one of the preceding claims, characterized in that it ~~may be used for a~~ *the* mix ~~which contains~~ *is of a type comprising expanded* ~~granulates of the expanded type~~.

~~6.~~ 5. Plant for manufacturing sheets of agglomerate material using the method according to any one of the preceding claims and comprising, in succession, a first

r preparing a mix by mixing a granulate of predetermined particle size consisting of organic resins, a second station (30) for distributing said ray mould (12) so as to form a layer of mix, a third vacuum vibro-ution (40) for obtaining a compacted sheet, and a final hardening station g at least one heating oven for catalysis of the organic binder so as to al sheet, characterized in that an intermediate station (50) is arranged hird vibro-compaction station (40) and said final hardening station (60) *means generating of electromagnetic waves having a frequency less than* ~~ielectric~~ preheating ~~of~~ said compacted sheet *up to a temperature lower ature at which catalysis of the binder starts.*

~~ccording to Claim 6 5, characterized in that said preheating station (50) gnetic waves with a frequency of less than 300 MHz.~~

it according to Claim ~~7~~ 5, characterized in that *said means in the on (50) are able to generate* electromagnetic waves having a frequency of 1 35 MHz ~~are used in said preheating station (50)~~.

* * * * *